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TECHNICAL TRAINING PUBLICATION

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C.B. AND AUTOMATIC TELEPHONES.

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1. INTRODUCTION.

1.1 Many different types of C.B. manual and automatic telephones have been used and some early types are shown on page 2. The types most commonly used at present are in the 300 and the 400 series, and these are available in table and wall models.

1.2 C.B. manual and automatic telephones in the different series are identified by the code letters.

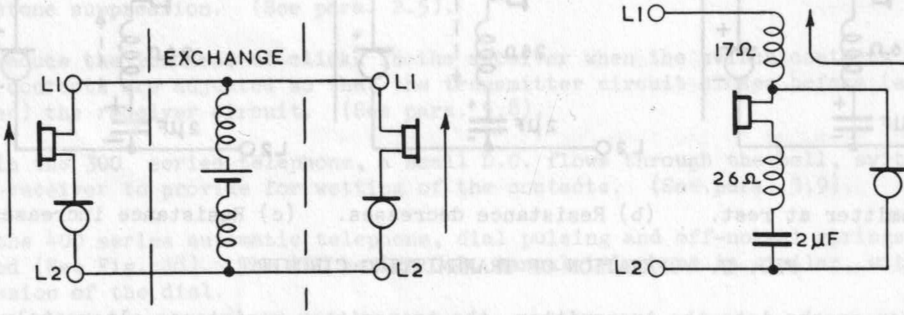
- CBT for a C.B. Manual Table Telephone,
- CBW for a C.B. Manual Wall Telephone,
- AT for an Automatic Table Telephone,
- AW for an Automatic Wall Telephone.

1.3 This Paper describes the principle of operation of the early type telephones, and the modern handset C.B. manual and automatic telephones, which use the anti-sidetone induction coil.

EARLY C.B. MANUAL AND AUTOMATIC TELEPHONES.

2. BASIC C.B. MANUAL TELEPHONE.

2.1 The modern C.B. telephones have been developed from the early circuits. In the first C.B. telephone, a transmitter and receiver were connected in series at each end of the telephone line to provide a two-way speaking circuit (Fig. 1(a)).



(a) (b)

FIG. 1. C.B. SPEAKING CIRCUITS.

This circuit has two main defects:-

(a) There is no provision for matching the transmitter to the line or the line to the receiver for maximum power transfer.

(b) The D.C. from the exchange battery for the transmitter operation also flows through the receiver coils, and tends either to oppose and weaken the permanent magnet in the receiver or to saturate the magnetic circuit, depending on the direction of current flow. In either case, the efficiency of the receiver is reduced.

2.2 These defects are overcome by adding a two-winding induction coil and a 2μF capacitor (Fig. 1(b)). As the transmitting and receiving efficiencies are essentially a compromise, the number of turns of each winding is designed to provide some degree of impedance matching for each direction of transmission. The Induction Coil No. 14 (I.C. 14) is a typical two-winding open core induction coil and consists of:-

(a) a 17 ohm winding of 1700 turns,

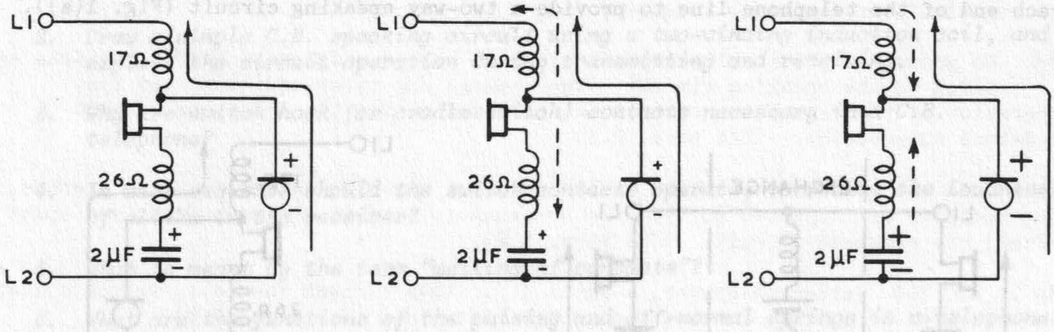
(b) a 26 ohm winding of 1400 turns.

The open core prevents magnetic saturation due to the transmitter current flowing through the 17 ohm winding.

The 2μF capacitor "blocks" the D.C. from flowing through the receiver, and also prevents the receiver and the 26 ohm winding from shunting some of the D.C. from the transmitter.

2.3 **THE TRANSMITTING CIRCUIT (FIG. 2).** During transmitting conditions, the 26 ohm winding can be considered as the primary of an auto-transformer of which the 17 ohm and 26 ohm windings in series, form the secondary. The transmitter is connected to the primary, and the turns ratio of the windings is designed so that the transmitter is approximately matched to the impedance of the line and distant telephone.

D.C. from the exchange battery flows through the transmitter and the 17 ohm winding. The P.D. across the transmitter also exists across the plates of the capacitor. The polarities are shown in Fig. 2(a).



(a) Transmitter at rest. (b) Resistance decreases. (c) Resistance increases.

FIG. 2. OPERATION OF TRANSMITTING CIRCUIT.

When a person speaks into the transmitter, the transmitter resistance alternately decreases and increases as explained in the paper "Transmitters and Receivers".

When the resistance decreases (Fig. 2(b)), the current increases slightly through the 17 ohm winding and the line, and the P.D. across the transmitter decreases. The capacitor discharges so that its P.D. equals that across the transmitter. The discharge current flows through the 26 ohm winding and induces a current in the 17 ohm winding which further increases the line current.

Conversely, when the resistance increases (Fig. 2(c)), the line current decreases slightly, and the P.D. across the transmitter (and capacitor) increases. The capacitor charging current flows through the 26 ohm winding in the opposite direction and the induced current in the 17 ohm winding further decreases the line current.

Summarising, in terms of the auto-transformer action, the A.C. component of speech developed by the transmitter causes an alternating speech current to flow through the 26 ohm winding. This induces an e.m.f. of mutual induction across the 17 ohm winding, so that the speech voltage applied to line is the sum of the speech voltage across the the transmitter and that induced in the 17 ohm winding.

The induction coil, by its impedance matching action, provides a more efficient transfer of speech energy from the transmitter to line than in the case of the transmitter connected directly to line.

2.4 THE RECEIVING CIRCUIT (FIG. 3).

During receiving conditions, the 17 ohm winding can be considered as the primary and the 26 ohm winding as the secondary of a transformer. The line is connected to the primary and the receiver to the secondary; and the turns ratio is designed to match approximately the impedance of the line to that of the receiver.

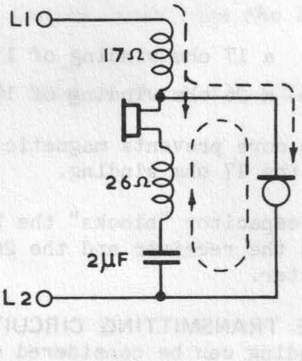


FIG. 3. OPERATION OF RECEIVING CIRCUIT.

Speech currents from the line flow through the 17 ohm winding and low resistance of the transmitter. This induces an e.m.f. of mutual induction across the 26 ohm winding and speech currents flow in the local circuit consisting of the receiver, transmitter and 2 μF capacitor. Fig. 3 shows the conditions at a particular instant during speech.

The speech currents from the line through the receiver, 26 ohm winding and 2 μF capacitor tend to oppose the induced current through the receiver; but their value is small as this shunt path offers a much greater opposition to A.C. than the transmitter.

The induction coil, by its impedance matching action, provides a more efficient transfer of speech energy from the line to the receiver than in the case of the receiver connected directly to line.

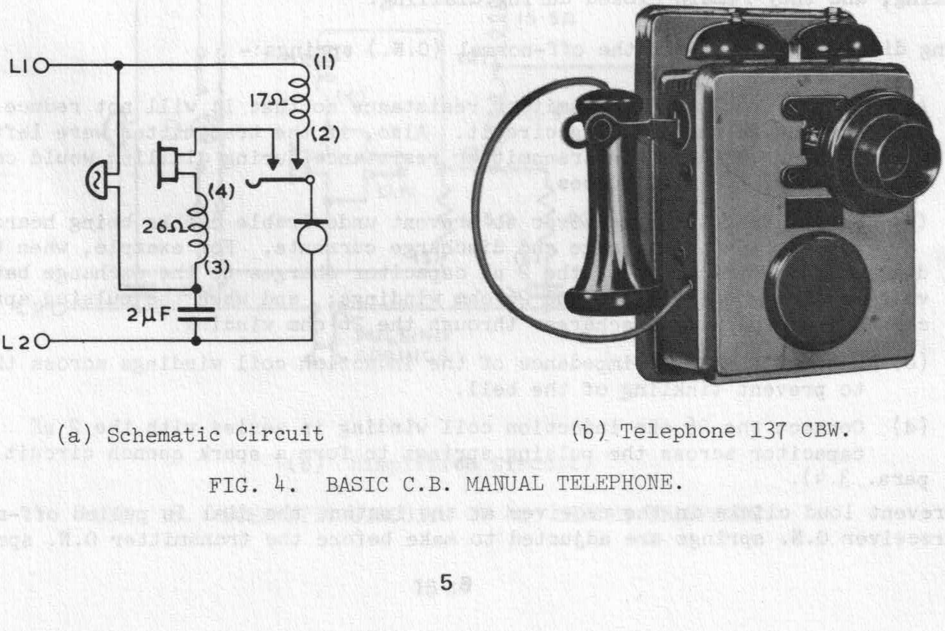
2.5 THE SIGNALLING CIRCUIT. A bell and switch-hook contacts are added to the speaking circuit, for signalling and switching purposes. Fig. 4(a) shows the basic circuit used in the type 137 CBW telephone (Fig. 4(b)) which is representative of the early type C.B. manual telephones.

Incoming Ring. When receiving an incoming ring from the exchange, the receiver is on the hook and the switch contacts are, therefore, open. Thus, the lower impedance of the speaking circuit does not shunt the bell. The ringing current passes through the bell and 2 μF capacitor in series.

Effect on speaking circuit. During a conversation, the receiver is removed from the hook and the switch contacts close to connect the speaking circuit to the line. The bell is connected across the speaking circuit; but because of the high impedance of the bell (about 18,500 ohms at 1 kc/s), it has no noticeable effect on the speaking circuit during either transmitting or receiving.

To signal the C.B. Manual exchange, the receiver is lifted from the hook and the switch contacts close. The D.C. flowing through the transmitter and 17 ohm winding also flows through and operates signalling apparatus at the exchange (as described in the paper "C.B. Exchange Principles") to indicate to the telephonist that the subscriber wishes to make a call.

The 2 μF capacitor (in series with the bell) and the switch-hook contacts ensure that a D.C. circuit or loop is not provided when the receiver is on the hook.



(a) Schematic Circuit (b) Telephone 137 CBW.

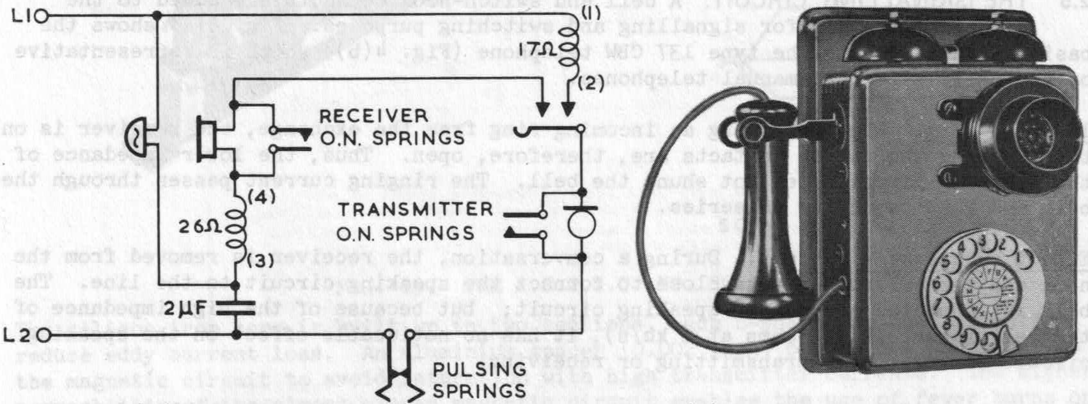
FIG. 4. BASIC C.B. MANUAL TELEPHONE.

3. BASIC AUTOMATIC TELEPHONE.

3.1 HOW SUBSCRIBERS SIGNAL THE AUTOMATIC EXCHANGE. When a telephone is connected to an automatic exchange, a telephone dial is provided, so that the calling subscriber can automatically operate the exchange equipment to set up the desired connection

In its simplest form, the dial consists of a pair of spring contacts, normally closed, but which, under the control of the subscriber, can be made to open and close any number of times from one to ten. These contacts, called pulsing springs, are connected so as to interrupt the D.C. through the telephone and exchange apparatus, when the switch contacts close and the dial is operated.

Fig. 5(a) shows the basic circuit used in the type 137 AW telephone (Fig. 5(b)) which is typical of the early type automatic telephones.



(a) Schematic Circuit (b) Telephone 137 AW.

FIG. 5. BASIC AUTOMATIC TELEPHONE

3.2 As shown in Fig. 5(a), additional spring contacts provided on the dial are connected across the transmitter and receiver. These contacts are normally open so as not to affect the operation of the speaking circuit. They are called off-normal springs as they operate when the dial is turned off-normal preparatory to dialling, and they remain closed during dialling.

During dialling conditions, the off-normal (O.N.) springs:-

(a) Short-circuit the transmitter resistance so that it will not reduce the current in the dialling circuit. Also, if the transmitter were left in circuit, any variation in transmitter resistance during dialling would cause distortion of the dial pulses.

(b) Short-circuit the receiver to prevent undesirable clicks being heard, due to the capacitor charge and discharge currents. For example, when the dial pulsing springs open, the 2 µF capacitor charges to the exchange battery voltage through the 17 ohm and 26 ohm windings; and when the pulsing springs close, the capacitor discharges through the 26 ohm winding.

(c) Connect the lower impedance of the induction coil windings across the bell, to prevent tinkling of the bell.

(d) Connect the 26 ohm induction coil winding in series with the 2 µF capacitor across the pulsing springs to form a spark quench circuit. (See para. 3.4).

To prevent loud clicks in the receiver at the instant the dial is pulled off-normal, the receiver O.N. springs are adjusted to make before the transmitter O.N. springs.

3.3 DEVELOPMENT OF DIALLING CIRCUIT. In the first automatic telephone circuit, the dial pulsing springs were connected in series with the transmitter and receiver (Fig. 6).

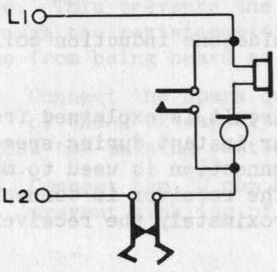
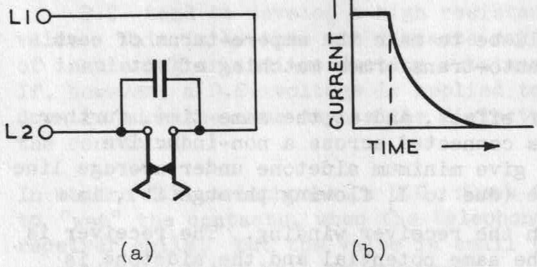


FIG. 6. EARLY AUTOMATIC TELEPHONE DIALLING CIRCUIT.

During dialling, the off-normal springs short-circuit the transmitter and receiver to connect the pulsing springs direct to the telephone line and exchange apparatus. When the pulsing springs open, the current through and, therefore, the flux about the inductive windings of the exchange apparatus, fall to zero almost instantly. This induces an e.m.f. of self-induction across the windings, which is about 700-900 volts for average length lines. This voltage unduly strains the insulation of the lines and equipment and is a hazard to staff working on the equipment. It also produces excessive sparking and deterioration on the pulsing contacts.



(a) (b)

FIG. 7. CAPACITOR ACROSS PULSING CONTACTS.

The e.m.f. of self-induction can be reduced by connecting a capacitor across the pulsing contacts during dialling conditions (Fig. 7(a)).

Whilst the contacts are closed, they short-circuit the capacitor, which is, therefore, unchanged. When the contacts open, the capacitor charges to the exchange battery voltage via the windings of the exchange apparatus. Now, a capacitor charging current is a gradually decaying current, being initially falling to zero with time (Fig. 7(b)). The current through the exchange equipment, therefore, does not fall to zero instantly but decays more gradually so that the e.m.f. of self induction is reduced, in practice, to a value of about 150 volts.

A disadvantage of Fig. 7(a) is that each time the contacts close, the short-circuited capacitor discharges through them. In time, the heavy discharge currents would cause these contacts to deteriorate. To prevent this, a resistance is connected in series with the capacitor to reduce the discharge current.

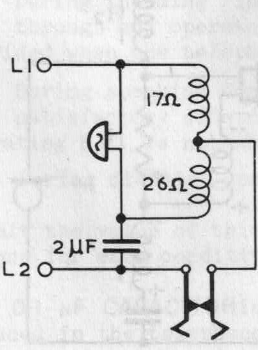


FIG. 8. SIMPLIFIED EARLY DIALLING CIRCUIT.

3.4 In early dialling circuits, the operation of the off-normal springs connected the resistance of the 26 ohm induction coil winding in series with the 2 μF capacitor during dialling (Fig. 8); but in the later handset telephones, non-inductive resistances are also used to reduce the discharge current.

The capacitance and resistance in series form a Spark Quench Circuit.

4. ANTI-SIDETONE INDUCTION COILS.

4.1 In the speaking circuit used in early C.B. telephones, sounds picked up by the transmitter are heard as *sidetone* in the local receiver. The disadvantages of sidetone are explained in the paper "Magneto Telephones".

To reduce sidetone, all modern telephones use an anti-sidetone induction coil (A.S.T.I.C.).

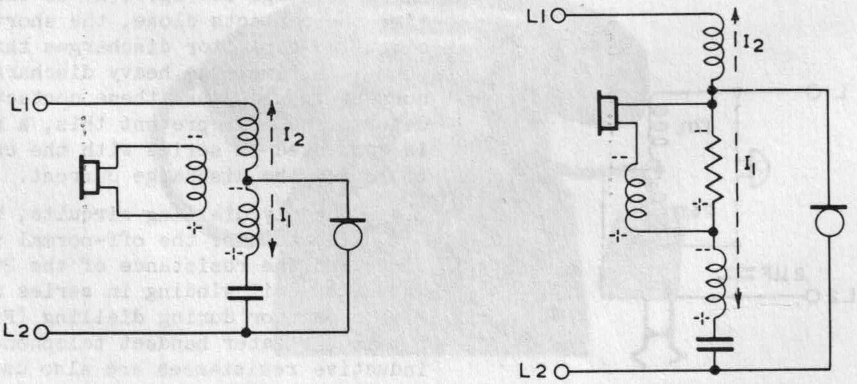
4.2 **THE PRINCIPLE OF OPERATION** of the A.S.T.I.C. circuit is explained from Figs. 9 and 10, which show the conditions at a particular instant during speech. As in the earlier speaking circuit, an auto-transformer connection is used to match approximately the transmitter to the line impedance. The receiver is connected to the additional winding, which is adjusted to match approximately the receiver to the line impedance.

Transmitting. In the A.S.T.I.C. circuit, speech signals are transmitted to line in the same manner as described for the earlier speaking circuit in para. 2.3.

Sidetone Suppression. In the basic arrangement of Fig. 9(a), when a person speaks into the transmitter, the A.C. components of speech, I_1 and I_2, flow through the two windings in opposite directions, and the magnetic effects produced by the windings tend to cancel. The resulting flux, however, induces an e.m.f. in the receiver winding, which produces some degree of sidetone current in the receiver.

One way to reduce this sidetone current would be to make the ampere-turns of each winding equal; but this would destroy the auto-transformer matching effect.

In Fig. 9(b), to retain the auto-transformer effect, and at the same time, further reduce the sidetone, the receiver circuit is connected across a non-inductive resistance, the value of which is chosen to give minimum sidetone under average line conditions. The P.D. across this resistance (due to I_1 flowing through it), is approximately equal to the e.m.f. induced in the receiver winding. The receiver is connected between points of approximately the same potential and the sidetone is greatly reduced.



(a) (b)

FIG. 9. OPERATION OF A.S.T.I.C. (TRANSMITTING).

To keep sidetone to a minimum at all frequencies transmitted by the telephone, the impedance of the path through which I_1 flows must vary with frequency in the same manner as the impedance of the line and distant telephone through which I_2 flows. In an attempt to simulate the variation in line impedance, therefore, the path for I_1 contains a balance network made up of the capacitor connected in series with the resistance of the A.S.T.I.C. winding N.I.R.

Receiving (Fig. 10). The major portion of the incoming speech current from line passes through one winding and the low resistance of the transmitter. Speech currents are induced in the receiver winding and flow in a local circuit through the receiver and the N.I.R.

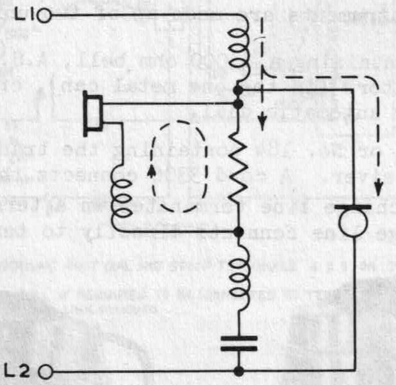


FIG. 10. OPERATION OF A.S.T.I.C. (RECEIVING).

The induced effect from any small speech current from line which flows through the high impedance path shunting the transmitter, tends to assist the current in the local receiver circuit.

4.3 In "anti-sidetone" telephones, the A.S.T.I.C. must be designed for satisfactory transmitting and receiving efficiencies, and sidetone suppression.

In practice, the optimum ratio of turns of the three windings and the impedance provided by each, differ for each function; for example, if the A.S.T.I.C. is designed for maximum transmitting efficiency, it may not necessarily give satisfactory receiving efficiency or sidetone suppression. Also, the line impedances to which the telephone may be connected, vary considerably depending on the primary constants, lengths and types of lines.

In the practical design of A.S.T.I.C.'s, therefore, it is necessary to adopt a compromise which gives satisfactory performance for each condition of operation. As a result, a number of types of A.S.T.I.C.'s have been used in different telephones over the years, each development giving some degree of improved performance compared with the earlier types, but they are all basically similar in operation to the arrangement described in para. 4.2.

Some of the open core types are:-

(a) the A.S.T.I.C. No. 14A used in the type 237 telephones.
(b) the A.S.T.I.C. No. 20 used in the type 232 telephones.
(c) the A.S.T.I.C. No. 22 used in the early type 332 telephones.
(d) the A.S.T.I.C. No. 27 used in the 300 series telephones.

For convenience, non-inductive resistances are also wound on these A.S.T.I.C.'s.

The 300 series telephones are the most commonly used of the above telephones.

5. 300 SERIES TELEPHONES.

5.1 Some of the telephones in this series are:-

(a) The types 332 CBT and 332 AT, developed in England. These were originally supplied in black, ivory, green and red.

(b) The types 300 CBT, 300 AT, 300 CBW and 300 AW, developed by the Australian Post Office. (Fig. 11).

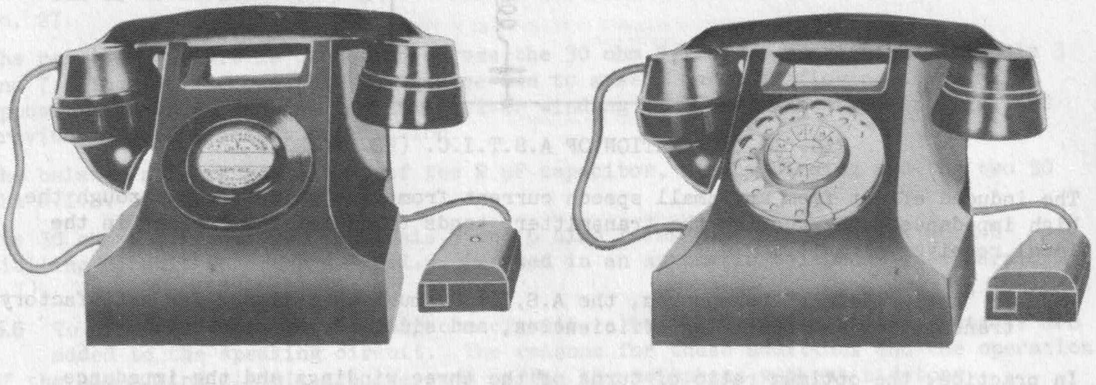
The general appearance of the corresponding table telephones is similar, and the main difference is in the construction and layout of the component parts. The schematic circuit and the operation of the table and wall telephones are similar.

5.2 Both table and wall instruments are made up of two units:-

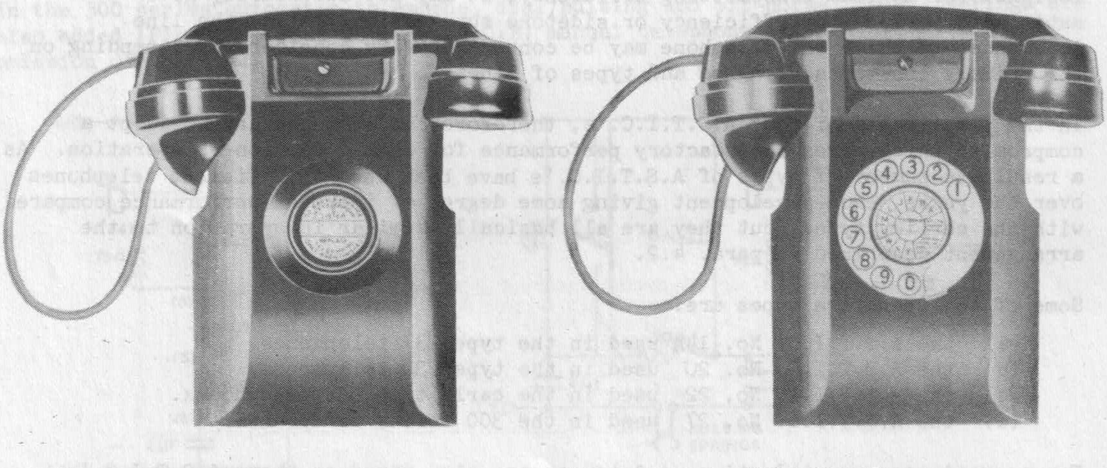
(a) A moulded case containing a 1,000 ohm bell, A.S.T.I.C. No. 27, 2 µF and 0.1 µF capacitors (in the one metal can), cradle switch contacts, and either a dummy dial or automatic dial.

(b) A handset No. 164 or No. 184 containing the transmitter No. 13 and either a type 1L or 2P receiver. A cord 3306 connects the handset to the case.

In the table models, the exchange line terminates on a terminal block No. 20/4. In the wall models, the exchange line connects directly to terminals inside the case.



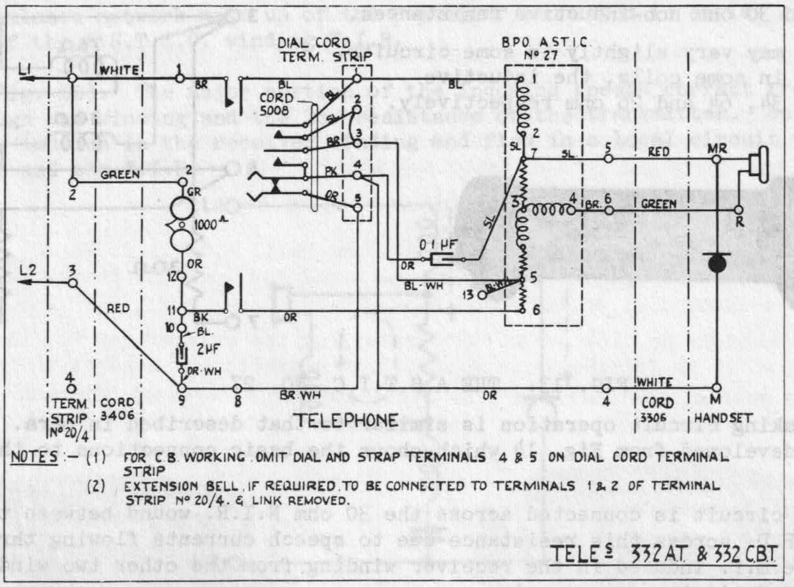
(a) 300 CBT. (b) 300 AT.



(c) 300 CBW. (d) 300 AW.

FIG. 11. 300 SERIES HANDSET TELEPHONES.

5.3 Fig. 12 shows typical schematic circuits for the types 332 and 300 telephones. These circuits are basically similar. (On early models of the type 332, an A.S.T.I.C. No. 22 was used instead of A.S.T.I.C. No. 27).

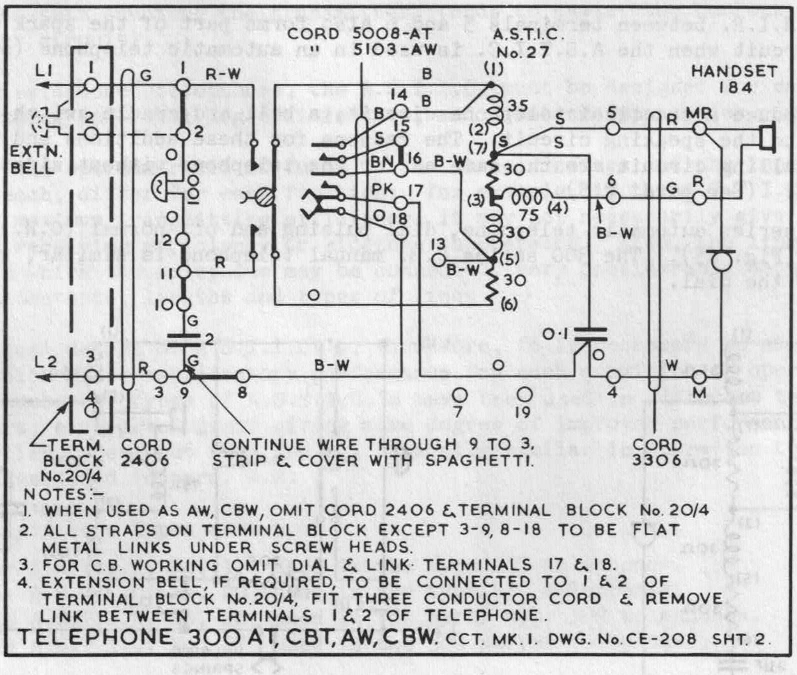

DIAL CORD TERM. STRIP
BPO ASTIC No 27
L1
WHITE
BR
BL
CORD 5008
GREEN
GR
1000Ω
L2
RED
OR
BK
2µF
OR-WH
0·1µF
BL-WH
SL
RED
MR
GREEN
R
TERM STRIP No 20/4
CORD 3406
TELEPHONE
BR.WH
WHITE
CORD 3306
HANDSET

NOTES :- (1) FOR C.B. WORKING OMIT DIAL AND STRAP TERMINALS 4 & 5 ON DIAL CORD TERMINAL STRIP

(2) EXTENSION BELL, IF REQUIRED, TO BE CONNECTED TO TERMINALS 1 & 2 OF TERMINAL STRIP No 20/4. & LINK REMOVED.

TELES 332 AT & 332 CBT

(a) 332 AT and 332 CBT Telephones.


CORD 5008-AT
" 5103-AW
A.S.T.I.C. No. 27
HANDSET 184
L1
R-W
EXTN. BELL
MR
R
B-W
0·1
L2
W
TERM. BLOCK No.20/4
CORD 2406
CORD 3306

CONTINUE WIRE THROUGH 9 TO 3. STRIP & COVER WITH SPAGHETTI.

NOTES:-

1. WHEN USED AS AW, CBW, OMIT CORD 2406 & TERMINAL BLOCK No. 20/4
2. ALL STRAPS ON TERMINAL BLOCK EXCEPT 3-9, 8-18 TO BE FLAT METAL LINKS UNDER SCREW HEADS.
3. FOR C.B. WORKING OMIT DIAL & LINK TERMINALS 17 & 18.
4. EXTENSION BELL, IF REQUIRED, TO BE CONNECTED TO 1 & 2 OF TERMINAL BLOCK No.20/4, FIT THREE CONDUCTOR CORD & REMOVE LINK BETWEEN TERMINALS 1 & 2 OF TELEPHONE.

TELEPHONE 300 AT, CBT, AW, CBW. CCT. MK. I. DWG. No. CE-208 SHT. 2.

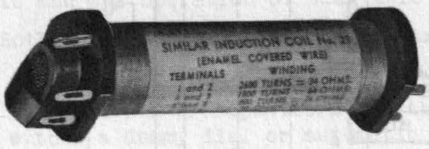
(b) 300 AT, CBT, AW, CBW Telephones.

FIG. 12. SCHEMATIC CIRCUITS OF 300 SERIES TELEPHONES.

5.4 **THE A.S.T.I.C. NO. 27(FIG. 13),** has five windings, the usual values being:-

- (a) a 35 ohm winding of 2,600 turns,
- (b) a 75 ohm winding of 1,800 turns,
- (c) a 30 ohm winding of 800 turns,
- (d) two 30 ohm non-inductive resistances.

These values may vary slightly in some circuits. For example, in some coils, the inductive windings are 34, 64 and 26 ohm respectively.


SIMILAR INDUCTION COIL No. 21
(ENAMEL COVERED WIRE)
TERMINALS
WINDING

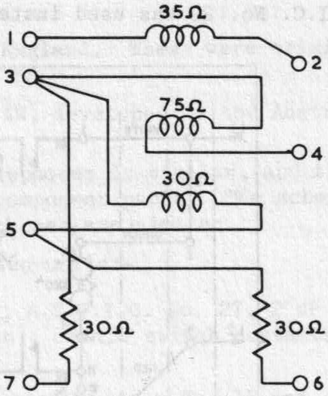

35Ω
1
2
3
75Ω
4
30Ω
5
30Ω
30Ω
7
6

FIG. 13. THE A.S.T.I.C. NO. 27.

5.5 The speaking circuit operation is similar to that described in para. 4.2, and can be developed from Fig. 14 which shows the basic connections to the A.S.T.I.C. No. 27.

The receiver circuit is connected across the 30 ohm N.I.R. wound between terminals 3 and 7. The P.D. across this resistance due to speech currents flowing through it, opposes the e.m.f. induced in the receiver winding from the other two windings, and provides a good sidetone suppression.

The balance network is made up of the 2 μF capacitor, 30 ohm winding and the two 30 ohm N.I.R.'s, connected in series.

The 30 ohm N.I.R. between terminals 5 and 6 also forms part of the spark quench dialling circuit when the A.S.T.I.C. is used in an automatic telephone (see para. 5.7).

5.6 To produce a practical telephone circuit, a bell and cradle switch contacts are added to the speaking circuit. The reasons for these additions and the operation of the signalling circuit are the same as for the telephone without sidetone suppression. (See para. 2.5).

In the 300 series automatic telephone, dial pulsing and off-normal (O.N.) springs are also added (Fig. 15). The 300 series C.B. manual telephone is similar, with the omission of the dial.

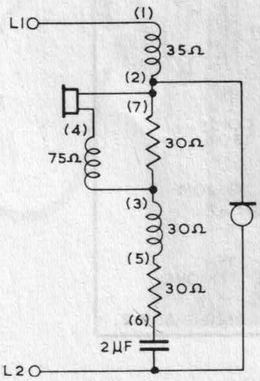

L1
(1)
35Ω
(2)
(7)
(4)
75Ω
30Ω
(3)
30Ω
(5)
30Ω
(6)
2μF
L2

FIG. 14. SPEAKING CIRCUIT.

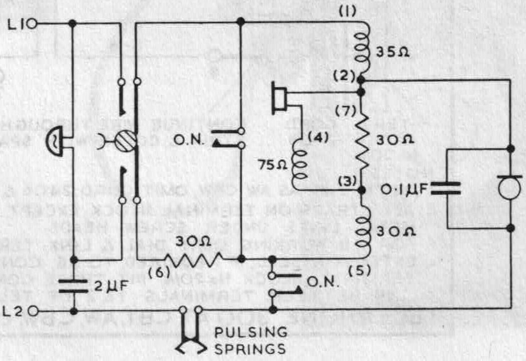

L1
(1)
35Ω
(2)
(7)
(4)
30Ω
O.N.
75Ω
(3)
0·1μF
30Ω
30Ω
(6)
(5)
O.N.
2μF
L2
PULSING
SPRINGS

FIG. 15. SIMPLIFIED CIRCUIT OF 300 SERIES TELEPHONES.

5.7 THE DIALLING CIRCUIT. During dialling, the off-normal springs operate to:-

(a) Short circuit the speaking circuit and connect the pulsing springs direct to the telephone line. This prevents the dial pulses from passing through the resistance of the speaking circuit and also from being heard as clicks in the receiver.

(b) Connect the spark quench circuit consisting of the 2 μF capacitor and 30 ohm N.I.R. across the pulsing contacts.

(c) Connect the 30 ohm N.I.R. across the bell, to prevent tinkling of the bell.

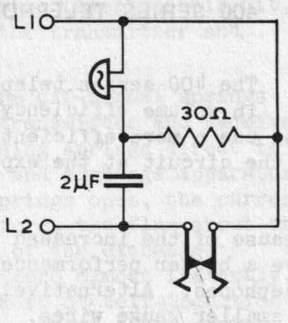


FIG. 16. DIALLING CIRCUIT.

5.8 SEQUENCE OF OPERATION OF CRADLE SWITCH CONTACTS. When the switch contacts are open, the capacitor is charged to the exchange battery voltage (about 50 volts) via the bell. At the instant the contacts close, the capacitor discharges through the telephone circuit to approximately the P.D. across the transmitter (about 5 volts). The discharge current normally causes clicks in the receiver. To reduce the loudness of the clicks, the contacts are adjusted so that the transmitter circuit closes before (and opens after) the receiver circuit. Thus, the initial high discharge current does not flow through the path that includes the receiving circuit.

5.9 WETTING OF CONTACTS. Experience has shown that contacts which do not carry D.C. tend to develop a high resistance to alternating speech currents of small value. This is because the contacts may become contaminated with a thin surface film of insulating or semi-conducting substances such as dust, tarnish, grease or water. If, however, a D.C. voltage is applied to the contacts as they close, the film breaks down in much the same way as the dielectric of a capacitor. This is called wetting the contacts.

In modern C.B. telephones, a D.C. flows through the bell and cradle switch contacts to "wet" the contacts, when the telephone is in use. The D.C. also flows through the receiver coils; but the value is small (less than 0.5 mA) and does not affect the sensitivity of the bell or receiver.

5.10 THE FUNCTIONS OF THE 2 μF CAPACITOR in the "anti-sidetone" telephone circuit are:-

(a) During incoming ringing conditions, it allows the ringing current to pass through and operate the bell; but ensures that a D.C. circuit is not provided when the telephone is not in use.

(b) During speaking conditions, it forms part of the balance network for satisfactory sidetone suppression; and also ensures that some of the operating D.C. is not shunted away from the transmitter.

(c) During dialling conditions, it forms part of the spark quench circuit.

As a result the value of this capacitor must be a compromise to give satisfactory performance for each condition of operation.

5.11 THE 0.1 μF CAPACITOR in parallel with the transmitter, prevents radio signals induced in the telephone line from being "detected" by the carbon granules in the transmitter, and heard in the telephone receiver. At radio frequencies, the reactance of this capacitor is much lower than the transmitter resistance, and the capacitor by-passes the radio signals around the transmitter. At voice frequencies, however, the capacitive reactance is much greater (X_c is about 1,600 ohms at 1,000 c/s) than the transmitter resistance, and the capacitor has negligible effect on the operation of the speaking circuit.

6. 400 SERIES TELEPHONES.

6.1 The 400 series telephones use a rocking armature receiver which is superior, both in volume efficiency and frequency response, to receivers previously used. They also use a more efficient A.S.T.I.C., designed to raise the transmitting efficiency of the circuit at the expense of some of the increased receiving efficiency.

Because of the increased transmitting and receiving efficiencies, these telephones give a better performance with existing lines than the equivalent 300 series telephones. Alternatively, for similar performance, they can be used on longer lines or smaller gauge wires.

The sidetone balance has been modified to suit the light gauge cables which are likely to be used more with the higher efficiency telephone. However, the sidetone balance is less effective on short lines and this results in loud sidetone under short line conditions.

6.2 Some of the telephones in this series, are the types 400 CBT and 400 AT (Fig. 17). These are available in black or ivory, and are made up of two units:-

(a) A moulded case (similar to the 300 series) containing a 1,000 ohm bell, A.S.T.I.C. No. 30, 1.8 μF and 0.9 μF capacitors (in the one metal can), cradle switch contacts, and either a dummy dial or automatic dial.

(b) A handset 400 containing the transmitter No. 13 and rocking armature receiver.

The exchange line terminates on a terminal block No. 20/4 which is connected to the case by accord 3406; and a cord 4306 connects the handset to the case.

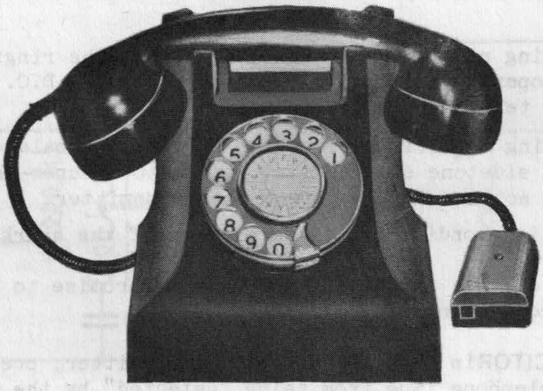
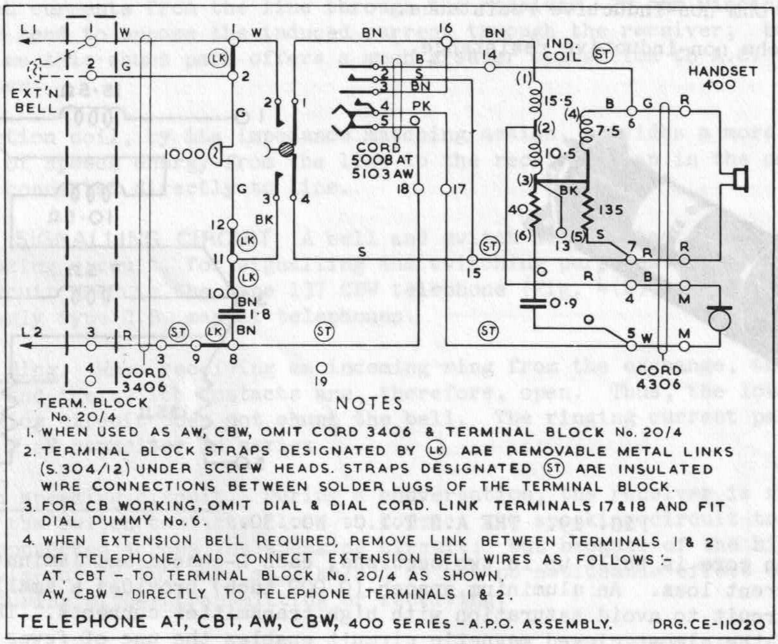


FIG. 17. 400 SERIES HANDSET TELEPHONE.

6.3 Fig. 18(a) shows the routed schematic circuit for the 400 series telephone. A simplified equivalent schematic circuit is shown in Fig. 18(b).

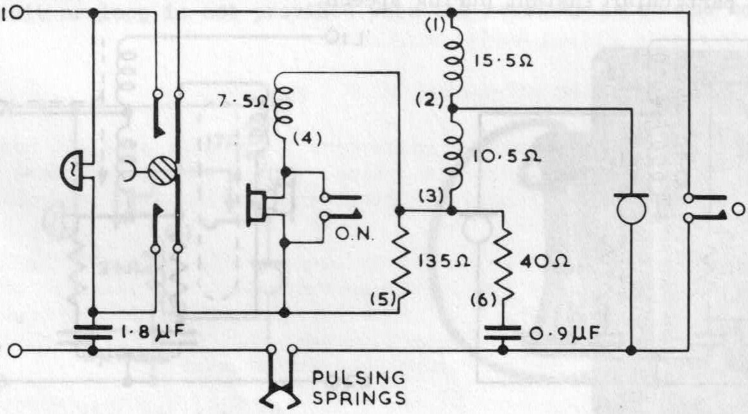

L1
EXT'N BELL
L2
W
G
R
TERM. BLOCK No. 20/4
CORD 3406
1000
BN
B
S
PK
CORD 5008 AT 5103 AW
IND. COIL
(1)
15·5
(2)
(3)
(4)
7·5
10·5
40
135
(5)
(6)
BK
0·9
1·8
O
M
HANDSET 400
CORD 4306
LK
ST

NOTES

1. WHEN USED AS AW, CBW, OMIT CORD 3406 & TERMINAL BLOCK No. 20/4
2. TERMINAL BLOCK STRAPS DESIGNATED BY (LK) ARE REMOVABLE METAL LINKS (S.304/12) UNDER SCREW HEADS. STRAPS DESIGNATED (ST) ARE INSULATED WIRE CONNECTIONS BETWEEN SOLDER LUGS OF THE TERMINAL BLOCK.
3. FOR CB WORKING, OMIT DIAL & DIAL CORD. LINK TERMINALS 17 & 18 AND FIT DIAL DUMMY No. 6.
4. WHEN EXTENSION BELL REQUIRED, REMOVE LINK BETWEEN TERMINALS 1 & 2 OF TELEPHONE, AND CONNECT EXTENSION BELL WIRES AS FOLLOWS :-
   AT, CBT - TO TERMINAL BLOCK No. 20/4 AS SHOWN.
   AW, CBW - DIRECTLY TO TELEPHONE TERMINALS 1 & 2.

TELEPHONE AT, CBT, AW, CBW, 400 SERIES - A.P.O. ASSEMBLY. DRG. CE-11020

(a) Routed Schematic Circuit.


L1
L2
(1)
15·5Ω
(2)
10·5Ω
(3)
7·5Ω
(4)
O.N.
135Ω
(5)
40Ω
(6)
1·8μF
0·9μF
O.N.
PULSING SPRINGS

(b) Simplified Circuit.

FIG. 18. SCHEMATIC CIRCUITS OF 400 SERIES TELEPHONE.

6.4 THE A.S.T.I.C. NO. 30. (Fig. 19) has five windings:-

(a) A 15.5 ohm winding of 1,220 turns.

(b) A 10.5 ohm winding 666 turns..

(c) A 7.5 ohm winding of 420 turns.

(d) A 135 ohm non-inductive resistance.

(e) A 40 ohm non-inductive resistance.

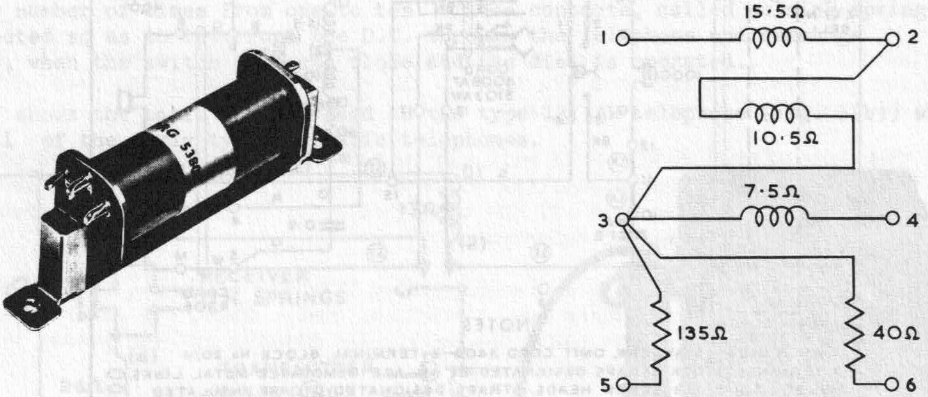
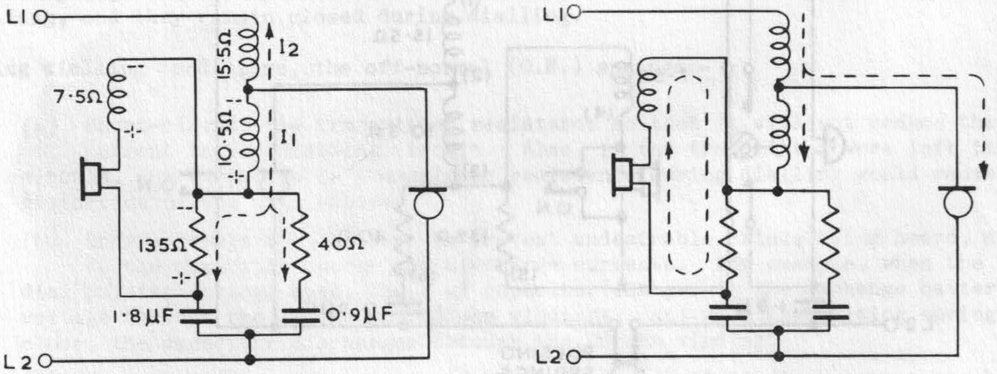


FIG. 19. THE A.S.T.I.C. NO. 30.

The silicon iron core is built up in two sections, each L-shaped and laminated to reduce eddy current loss. An aluminium spacer (0.002 inch) provides a small gap in the magnetic circuit to avoid saturation with high transmitter currents. The higher permeability of the almost closed magnetic circuit enables the use of fewer turns on each winding than are required when the magnetic circuit includes a large air path, as in the A.S.T.I.C. No. 27. Thus, the higher overall efficiency of the A.S.T.I.C. No. 30 is the result of reduced magnetic and copper losses.

6.5 The speaking circuit operation is similar to that described in para. 4.2, and can be seen from the simplified speaking circuit (Fig. 20), which shows the conditions at a particular instant during speech.



(a) Transmitting. (b) Receiving.

FIG. 20. OPERATION OF A.S.T.I.C. NO. 30.

The receiver circuit is connected across the 135 ohm N.I.R. wound on the A.S.T.I.C. The P.D. across this resistance due to speech currents flowing through it, opposes the e.m.f. induced in the receiver winding from the other two windings, and provides a greater degree of sidetone suppression.

Owing to the improved efficiency of the speaking circuit compared with the 300 series telephones, the balance network (comprising the 135 ohm and 40 ohm N.I.R's wound on the A.S.T.I.C., and the 1.8 μF and 0.9 μF capacitors) is designed to balance more accurately the line impedance variation to ensure satisfactory sidetone suppression over the voice frequency range.

6.6 To produce a practical telephone circuit, a bell and cradle switch contacts are added to the speaking circuit. The reasons for these additions and the operation of the signalling circuit are the same as for the telephone without sidetone suppression. (See para. 2.5).

To reduce the loudness of clicks in the receiver when the switch contacts operate, the contacts are adjusted so that the transmitter circuit closes before (and opens after) the receiver circuit. (See para. 5.8).

As in the 300 series telephone, a small D.C. flows through the bell, switch contacts and receiver to provide for wetting of the contacts. (See para. 5.9).

In the 400 series automatic telephone, dial pulsing and off-normal springs are also added (See Fig. 18). The 400 series C.B. manual telephone is similar, with the omission of the dial.

6.7 THE DIALLING CIRCUIT. During dialling, the off-normal springs operate to:-

(a) Short-circuit the resistance of the speaking circuit and connect the pulsing springs direct to the telephone line.

(b) Short-circuit the receiver to prevent dial pulses being heard.

(c) Connect the spark quench circuit across the pulsing contacts. The spark quench circuit consists of the 1.8 μF capacitor connected in series with a network comprising the induction coil windings, the balance resistors and 0.9 μF capacitor, and transmitter. This network has a D.C. resistance of about 30 ohms.

(d) Connect the low resistance of the spark quench circuit across the bell, to prevent tinkling of the bell.

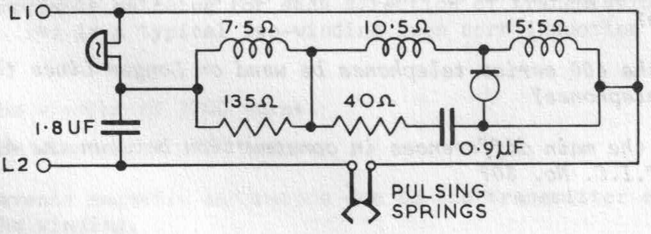


FIG. 21. DIALLING CIRCUIT.

6.8 As a matter of interest, there is no capacitor shunting the transmitter in the 400 series telephones, as in the 300 series telephones. Investigations have shown that such a capacitor is required in only a very few cases, and that it is more economic to provide it as an extra when required.

7. TEST QUESTIONS.

1. *What is meant by the code Letters AT, AW, CBT, CBW, when applied to telephones?*

2. *Draw a simple C.B. speaking circuit using a two-winding induction coil, and explain the circuit operation during transmitting and receiving.*

3. *Why are switch hook (or cradle switch) contacts necessary in a C.B. telephone?*

4. *In what sequence should the switch contacts operate, to reduce the Loudness of clicks in the receiver?*

5. *What is meant by the term "wetting of contacts"?*

6. *What are the functions of the pulsing and off-normal springs in a telephone dial?*

7. *Draw a simple spark quench circuit and explain its operation.*

8. *Explain how a simple three-winding induction coil can be used to reduce sidetone in a telephone circuit.*

9. *What is a necessary requirement of the balance network for satisfactory reduction of sidetone?*

10. *Draw the schematic circuit of an automatic telephone in which an A.S.T.I.C. is used, and explain its operation for each of the following conditions:-*

    (i) *transmitting speech,*

    (ii) *sidetone suppression,*

    (iii) *receiving incoming speech,*

    (iv) *receiving an incoming ring,*

    (v) *during dialling.*

11. *What are the functions of the 2 F and 0.1 μF capacitors in a 300 series telephone?*

12. *Why can the 400 series telephones be used on Longer Lines than the 300 series telephones?*

13. *What are the main differences in construction between the A.S.T.I.C. No. 27 and A.S.T.I.C. No. 30?*

END.

NOTES

NOTES

Commonwealth Printing Unit, Melbourne.